Delaware · Coastal Zone Management Program

IMPACT OF MARSH MANAGEMENT ON PLANT COMMUNITY STRUCTURE

FEB 1988

University of Delaware

RECEIVED
FEB 24 1988
EXECUTIVE ASSISTANT

Attachment E

COLLEGE OF MARINE STUDIES
LEWES COMPLEX
LEWES, DELAWARE 19958-1298

(302) 645-

February 18, 1988

Mr. David Hugg, III
Executive Assistant
Department of Natural Resources and
Environmental Control
89 Kings Highway
P. O. Box 1401
Dover, DE 19903

Dear Dave,

Enclosed is a brief report on the progress to date on the OMWM project where we are studying the effect of timing of burial with mineral ditching spoil on the regrowth of plants through the sediment deposits. Measurements taken thus far indicate that the May burial is better than March or July. We have no data as yet on the plots buried in October and we are waiting until we see a full season's growth before making any recommendations regarding timing of burial. It does appear clear that Distichlis spicata recovers better than Spartina patens from burial by this spoil. It may be necessary to plant Spartina patens if it is desired to have this as the dominant species on spoils such as we used, but it's too early in the experiment to be certain of this possibility.

Thank you for your financial help and the cooperation of personnel in your department, especially Bill Meredith and those people that ran the ditcher and helped us to get the ditching spoil when we needed it. This project, along with other marsh management efforts, provides a knowledge of wetlands ecology to answer serious environmental problems in Delaware.

If there is anything I can do to help explain what we have done, let me know and I'll visit your office.

Sincerely,

Jack

John L. Gallagher, Professor
Marine Biology and Biochemistry

JLG/rr

Enclosure

IMPACT OF MARSH MANAGEMENT ON PLANT COMMUNITY STRUCTURE

Report to

Delaware Department of Natural Resources
and Environmental Control

From

John L. Gallagher
Professor

Maureen J. Mills
Marine Scientist

Halophyte Biology Laboratory
College of Marine Studies
University of Delaware
700 Pilottown Road
Lewes, DE 19958

Date: 18 February 1988

INTRODUCTION

The marshes in the state of Delaware are managed in order to enhance waterfowl and wildlife production and use as well as for mosquito control by the Department of Natural Resources and Environmental Control (DNREC). In its Open-Marsh Water Management program the Mosquito Control Section of DNREC uses a rotary ditcher to create canals and small pools where fish can survive between spring tides and from where the fish can disperse over the marsh surface to forage for mosquito larvae. While creating this open-water habitat, the ditcher spreads the spoil material over a wide area as a water-slurry. Although older techniques previously employed by the department resulted in the development of shrubs and the loss of herbaceous communities where the dragline piled the dredged material in numerous small mounds along the ditches, the present technique covers the adjacent marsh with no more than 5 to 10 cm of sediment (after settling), which hopefully will have less effect on the species composition of the plant communities involved and hence less perturbation on the ecosystem.

Documentation of the research done by DNREC indicates that peat and mud deposits are quickly revegetated by the same species which were buried; however, a post-depositional species-shift is often found in areas consisting of a mineral sands spoil-type (Bill Meredith, personal communication). The purpose of this project is to determine the optimal season for using the rotary ditcher in a sand-substrate marsh; specifically, the results should pinpoint any period during the phenology of the plant species that are more detrimentally affected by burial when they can better re-establish themselves in the spoil material by producing new shoots. This information can then be utilized by wetlands managers in the scheduling of construction operations which involve the use of the rotary ditcher in mineral substrates in order to minimize the impact of sediment burial on the plant community.

PROJECT OBJECTIVES

This project will provide DNREC with information regarding the effect of the timing of the marsh surface burial on salt hay plant community regrowth and species composition. This research will focus on determining if timing the construction of ponds and ditches in the marsh can minimize the impact of coarse sediment deposition.

Specific Objectives for 1987-1988

Two field sites were established in Canary Creek Marsh, Lewes, Delaware (Figures 1 and 2). Site One, located on the fringe of a *Spartina alterniflora* community, is generally wetter than the second site and is composed of *Distichlis spicata* and *Spartina patens* communities (averaging 25-to-1 on an aerial culm density basis),

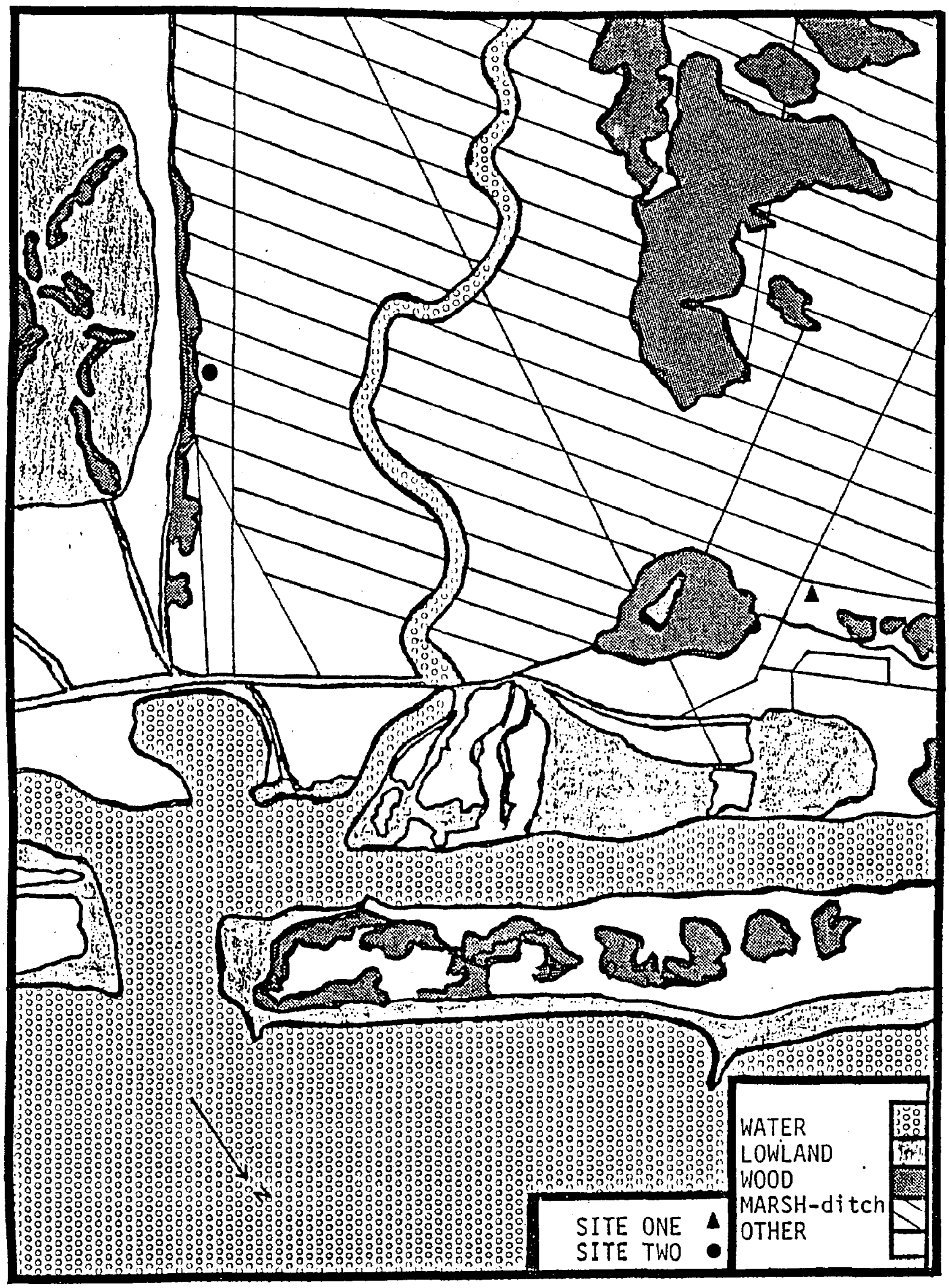

Figure 1. Map of site locations for marsh burial study in connection with Open-Marsh Water Management.

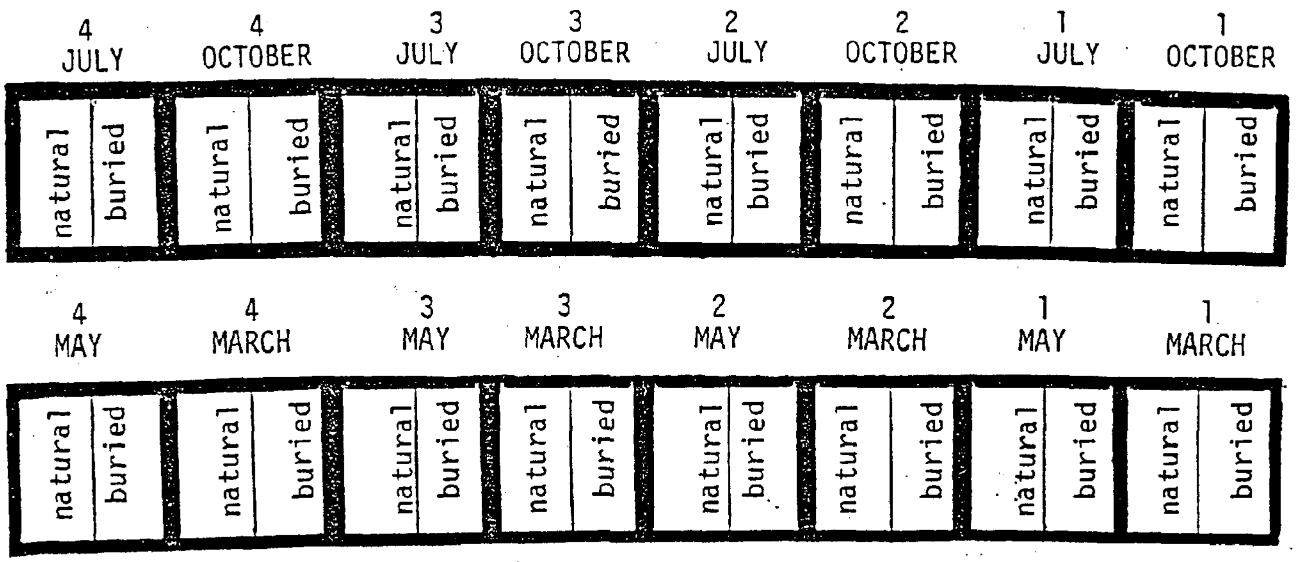

Figure 2. Plot layout for each burial study site.

while Site Two, situated on the lowland side of an *Iva frutescens* stand, also consists of *Distichlis spicata* and *Spartina patens* communities (although in a 6-to-1 average aerial culm density) but on better-drained sandier substrate (Figures 3, 4, and 5). Marsh surface burials at both sites was done with substrate from under the shallow part of the marsh at times during the year which corresponded with various plant phenological events.

Plant regrowth in the buried plots was monitored monthly as were the control plots. Periods of belowground plant activity throughout the year was accomplished by noting the parameters of root and rhizome production and belowground reserve storage.

Specific Objectives for 1988-1989

During the next calendar year the collection of the data on the manipulated plots previously established in 1987, as well as of the natural aerial phenological data, will continue. Subsequently, the data summarily analyzed will aid in the preparation of recommendations and in the writing of manuscripts describing the results of this research.

METHODOLOGY

Each of the aforementioned sites in Canary Creek Marsh (Figure 1) consists of a series of eight blocks, with each block comprised of four 1 m^2 plots in a square format which are each further subdivided into 0.5 m^2 plots (Figure 2). Corrugated plastic sheeting, driven into the marsh to a depth of 25 cm in order to prevent rhizome growth between the individual plots, extends 20 cm above the soil surface; no ponding of water on the marsh surface was noted although no drainage holes were drilled.

Material excavated near both sites by the DNREC rotary ditcher was used to bury the marsh surface. Rhizomes and large roots were removed in order to prevent the inadvertent import of propagules to the buried plots. Coverage to a settled depth of 6 cm occurred on 31 March, 28 May, 29 July, and 29 October 1987 during specific phenological events in the cycle of the plants. March represents the period just prior to the burst of spring growth when initiation of new shoot growth as well as the amount of belowground reserves is high. Late May is near the end of the burst of spring growth and a point of presumed minimal plant belowground reserves. July was thought to reflect the time for initial belowground reserve storage and flowering. October is when seeds are maturing and the reserves for spring growth should be stored.

Live stem counts for each species were made in randomly selected triplicate 0.05 m^2 quadrats in each of the non-buried plots in each of the eight blocks each month beginning in April and continuing through November. These data reveal the dynamics of shoot density of the two plant species in the natural and perturbated environments. In order to eliminate any edge-effect in the buried plots where the excavated substrate met the corrugated plastic, stem counts in these plots were taken from triplicate 0.05 m^2 quadrats located along the central longitudinal axes of the individual plots.

Belowground development and growth was evaluated for two cores 15 cm in diameter and 25 cm in depth taken from each natural plot on each of the four sampling dates. One of each pair of cores was returned to the laboratory where the regrowth of the aerial portion of the plants, while being incubated in the dark at 20°C and periodically moistened with freshwater, is a measure of the available belowground reserves. The other core of the pair was horizontally divided into 5 cm segments which were washed through 2 mm (no. 10 / Tyler equivalent 9) mesh screen, carefully separated into live and dead root and rhizome material (on the basis of such viability identifiers as color, texture, and density relative to water), and dried in a 60°C oven until reaching constant weight. No attempt was made to sort the belowground biomass by plant species.

The core holes were refilled with the material used to bury the plots and their boundaries were carefully marked with plastic pot labels. At the next coring date the soil was removed and the roots and rhizomes which grew into the soil collected (Gallagher et al., 1984). The technique for this re-coring was adapted to the particular substrate so that PVC pipe in the dimensions of the core sample was carefully inserted directly around the original coring space after a long knife was used to cut through the cylindrical column, and the enclosed material was then hand-scooped into labelled plastic bags. This recovered material was then returned to the laboratory where it was sorted, dried, and weighed in a manner identical to the treatment of the profile cores as mentioned in the previous paragraph.

RESULTS AND DISCUSSION

The following represents the data collected and the analyses of that data from the beginning of the project in the spring of 1987 until February of 1988. To date we have done relatively little interpretation of the data since sets are as yet incomplete because we do not have a full year of field data on some aspects of the project; for example, root and rhizome growth during the October 1987 to March 1988 period has not yet been measured. Other aspects, such as the regrowth through the burial material, will require at least another growing season with intensive sampling and a few observations.

Figure 3 illustrates the total live culm density for the combined species of salt hay at the two sites. The pattern of growth through the season, as represented by the CONTROL curves,

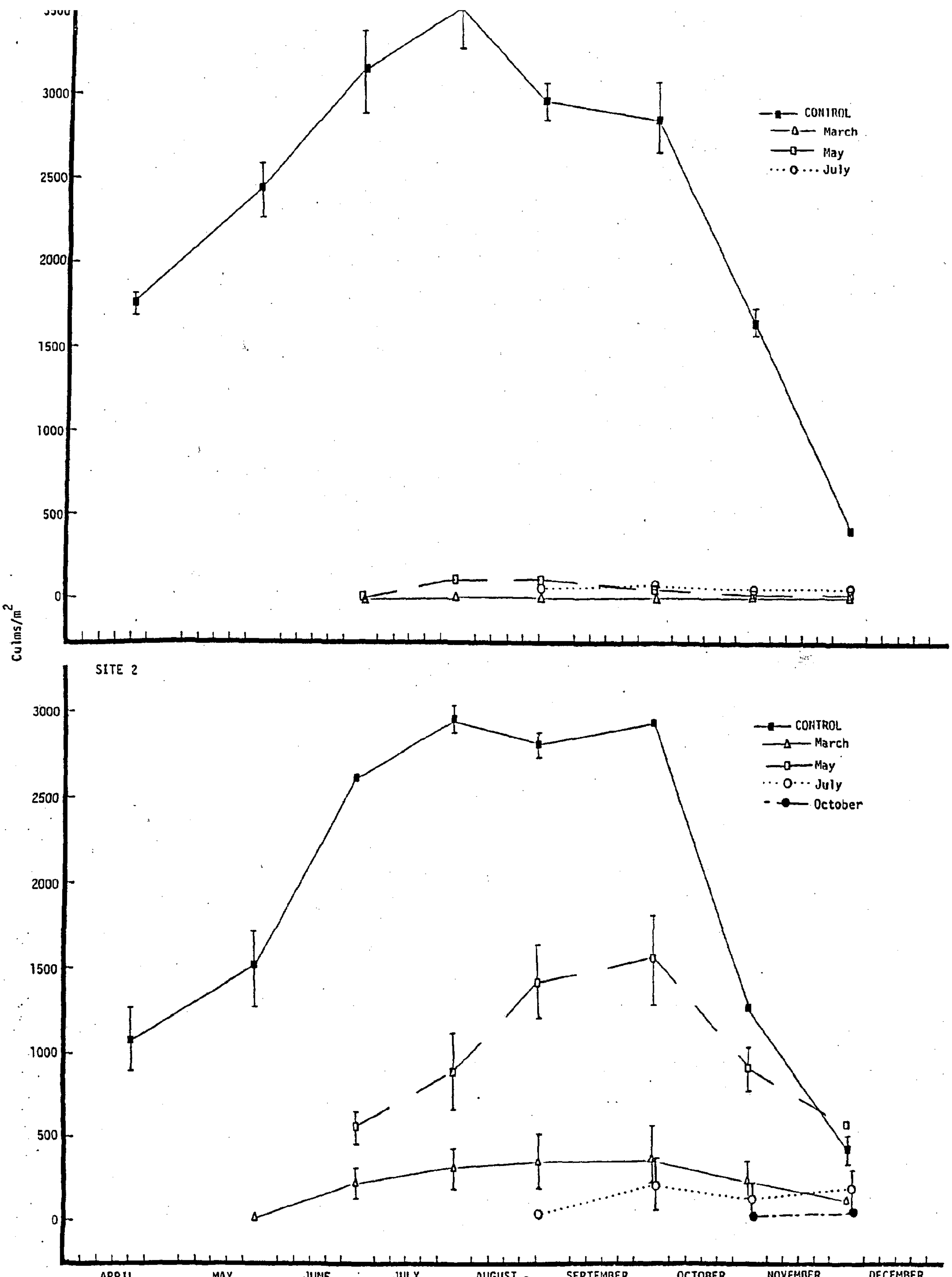

Figure 3. Total live culm density (culms/m^2) for both species, Distichlis spicata and Spartina patens, at both sites during the growing season in the control marsh plots and the regrowth in the buried plots. Bars equal ± 1 S. E.

was quite similar at the two sites with a maximum of 3000 to 3500 culms/m^2. However, the treatment plots responded very differently in the two areas after burial: Site 1 had little or no regrowth after any of the burials while Site 2 exhibited much better recovery, especially from the May burial. Figures 4 and 5 indicate both the similarity of the two individual species of salt hay at the sites in the occurrence of their respective growing seasons and the difference in their response to burial (note the different scales for culm densities of the two species). D. spicata reached its maximimum aerial density of approximately 3300 culms/m^2 in mid-summer at Site 1 and approximately 2500 culms/m^2 between June and September at Site 2. Very little regrowth of D. spicata was noted for Site 1 while the maximum regrowth at Site 2 was reached just prior to the September sampling. Considerably fewer stems of S. patens existed at either site, especially Site 1, with similar early season density curves for the two sites as illustrated in Figure 5; this species' aerial density peaked twice, initially sometime before or during April and again in late summer or early fall, with approximately 200 and 100 (Site 1) and 600 and 400 (Site 2) culms/m^2, respectively. Very little regrowth occurred for S. patens after any burial.

With regard to belowground recoverable reserves, measurement of regrowth in the dark (Figures 6 and 7) and the percentage of cores still producing (Figures 8 and 9) yielded the following generalizations based upon these presently incomplete data sets. Eighty-one and 69 percent of the D. spicata and 6 and 64 percent of S. patens cores at Sites 1 and 2, respectively, are still producing regrowth. Although more reserves for both species are available at Site 1, more S. patens regrew from all Site 2 cores while the greatest amount of regrowth produced was from D. spicata cores at either site for March and May samplings. Reserves are consumed for regrowth at a faster rate for S. patens at both sites. Figure 8 indicates that the May cores at both sites, with only 25% still producing, probably either had less reserves than the March plants with no extinct cores, or the reserves which they had were more readily mobilized into the aboveground components; this latter possibility would be consistent with the better regrowth obtained in the May burial plots. For July and October all cores continue to produce D. spicata at both sites and 75% of all of these same cores are also still producing S. patens at Site 2 although at Site 1 this salt hay species is no longer produced in 94% of the cores (the only exception being a single October core). These data are consistent with the observations on aerial regrowth through the ditching spoil. Once all the reserves have been measured, following extinction of all the 1987 cores, we should have some possible explanations for the field regrowth portion of this study.

All of the analyses of belowground biomass has thus far concerned the control plots with the buried plots scheduled for similar analyses during the 1988 growing season. Tables 1 through 4 show the live and dead root and rhizome profiles for the salt marsh hay species at both sites. Although no statistical analyses have yet been performed on these data, when considering gross

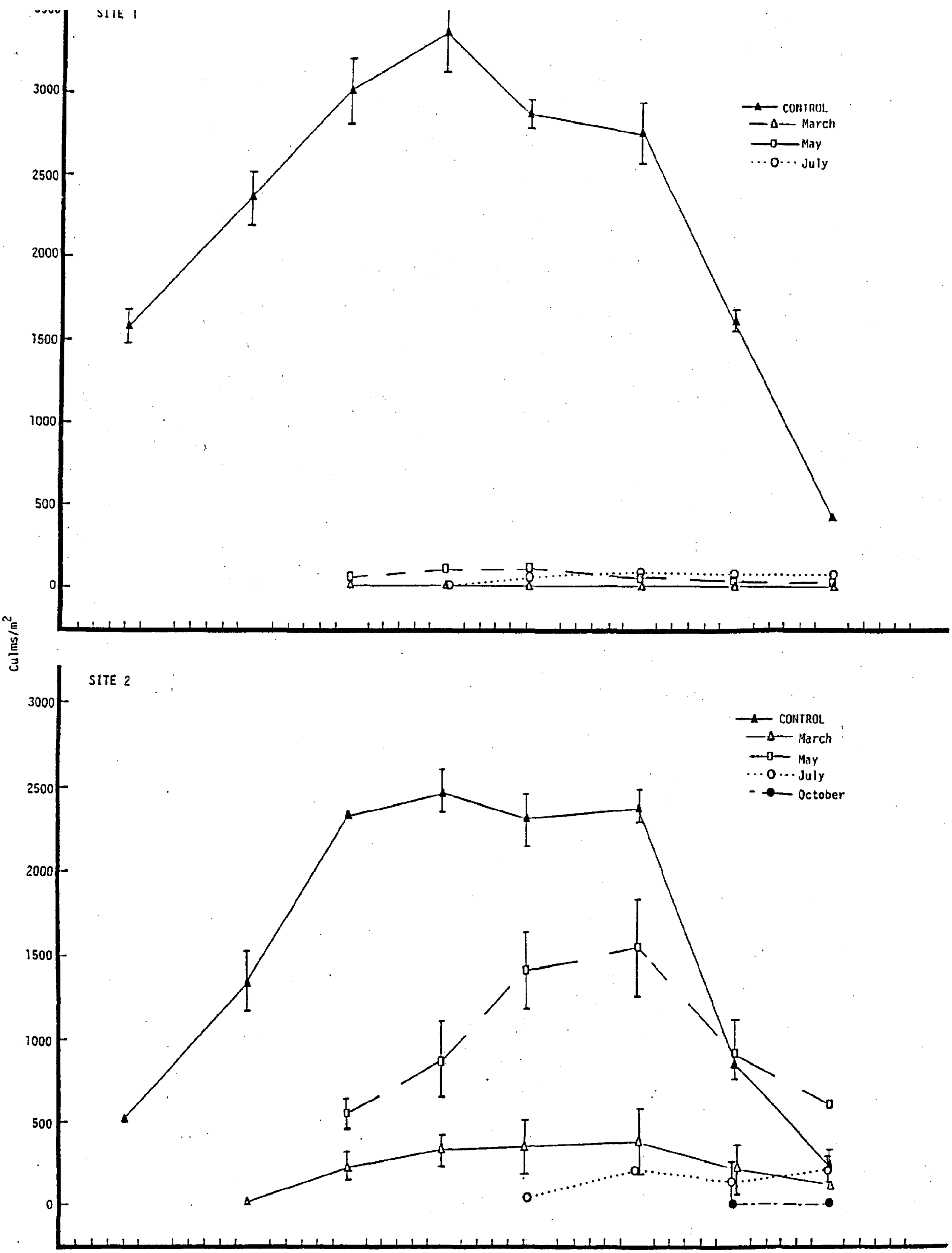

Figure 4. Live culm density (culms/m^2) for <u>Distichlis spicata</u> at both sites during the growing season in the control marsh plots and the regrowth in the buried plots. Bars equal $\pm$ 1 S. E.

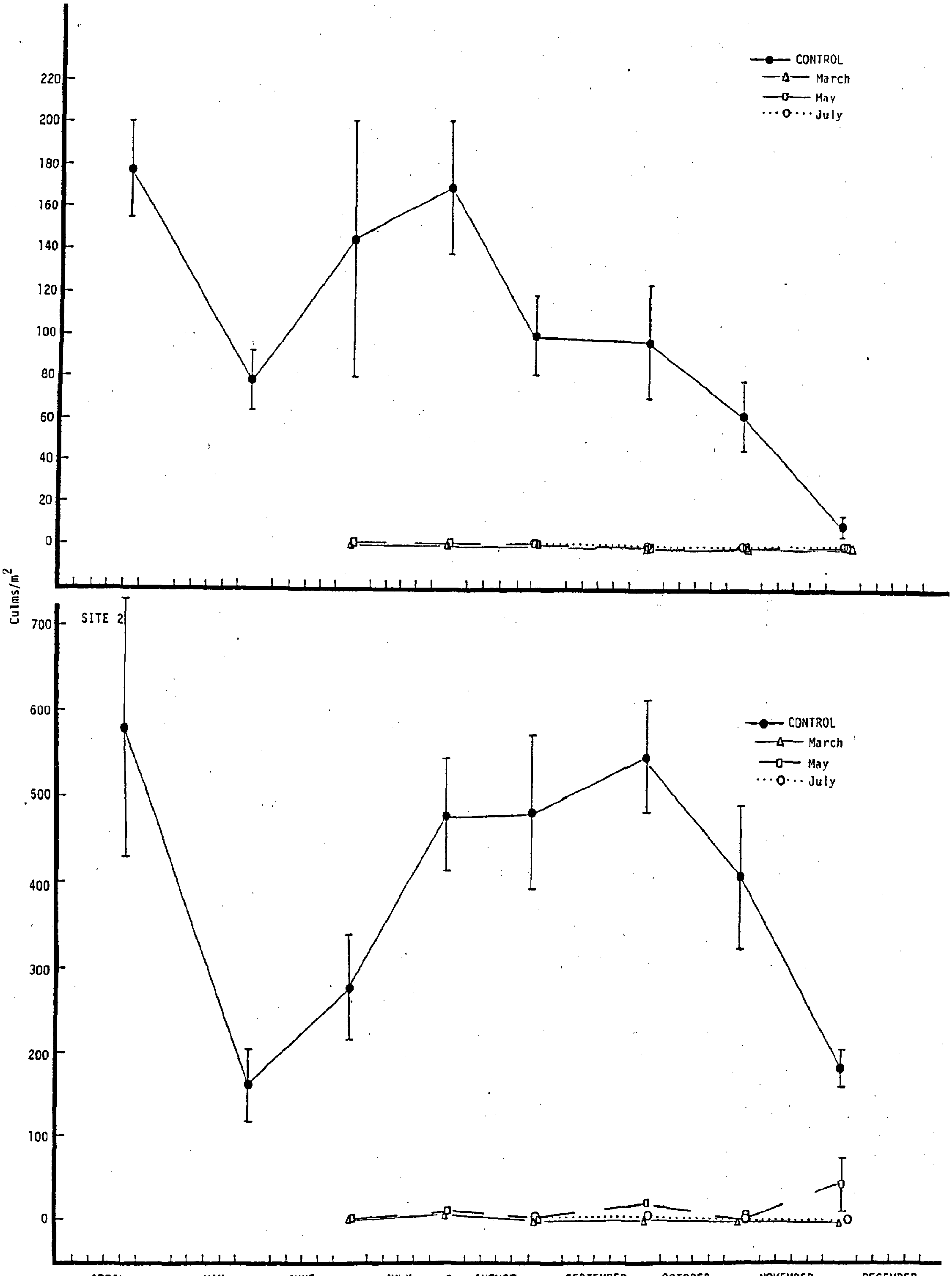

Figure 5. Live culm density (culms/m^2) for Spartina patens at both sites during the growing season in the control marsh plots and the regrowth in the buried plots. Bars equal $\pm$ 1 S. E.

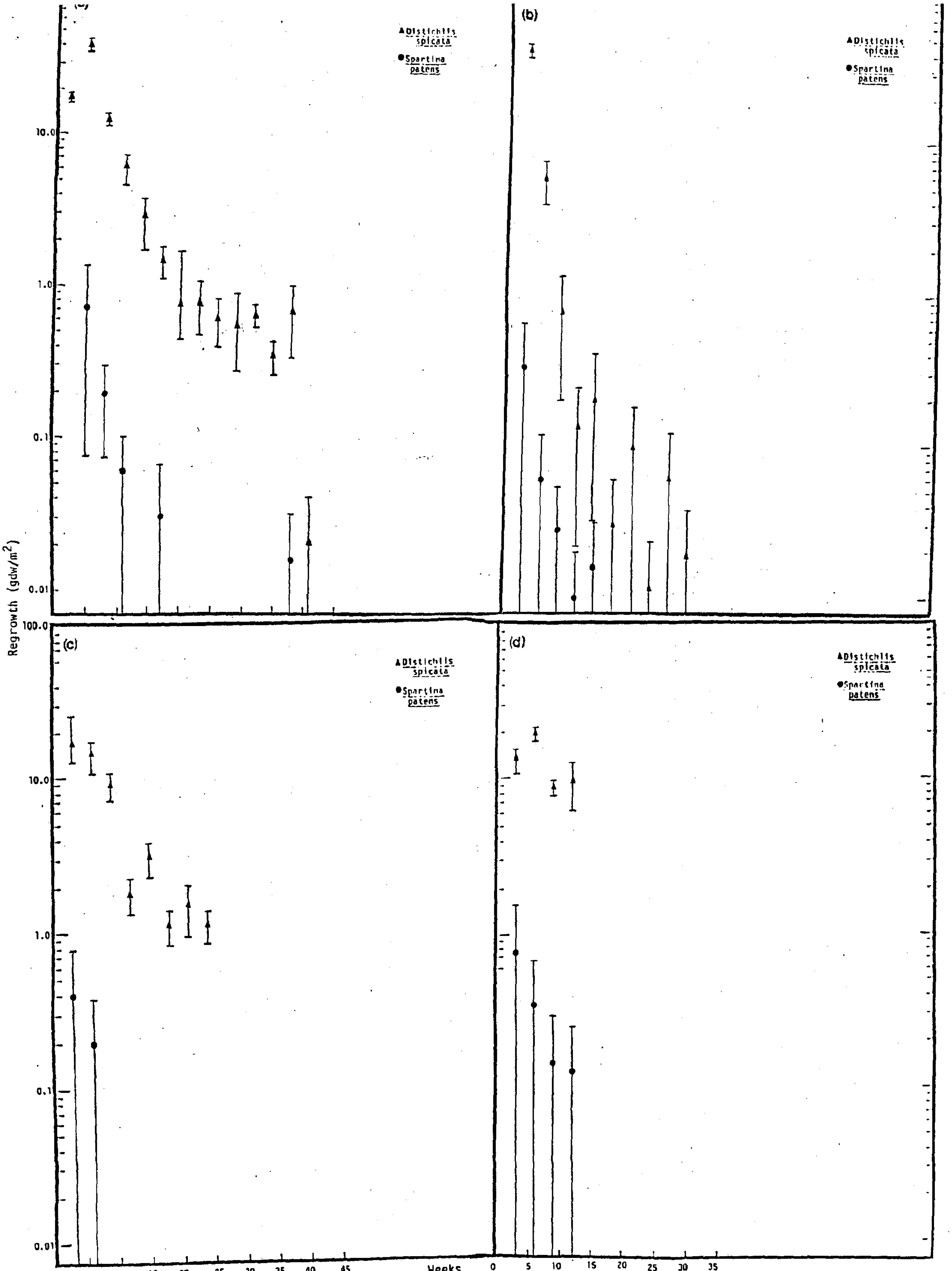

Figure 6. Regrowth (g dry weight/m^2) of salt marsh hay, Distichlis spicata and Spartina patens, collected in (a) March, (b) May, (c) July, and (d) October 1987 from Site 1 in Canary Creek Marsh, ... and incubated in the dark at 20°C. Bars equal + 1 S. E.

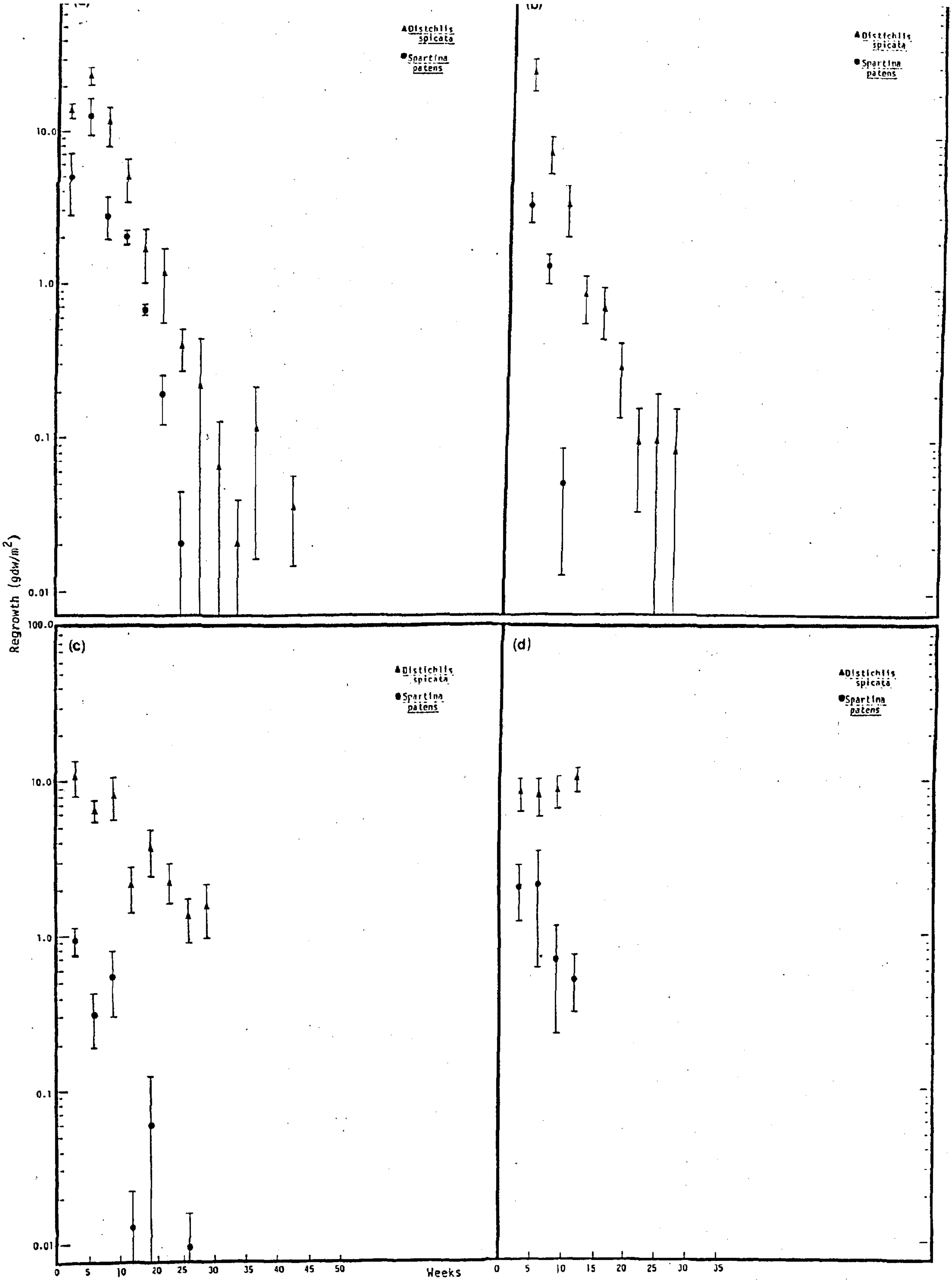

Figure 7. Regrowth (g dry weight/m^2) of salt marsh hay, Distichlis spicata and Spartina patens, collected in (a) March, (b) May, (c) July, and (d) October 1987 from Site 2 in Canary Creek Marsh, Lewes, Delaware and incubated in the dark at 20°C. Bars equal ± S. E.

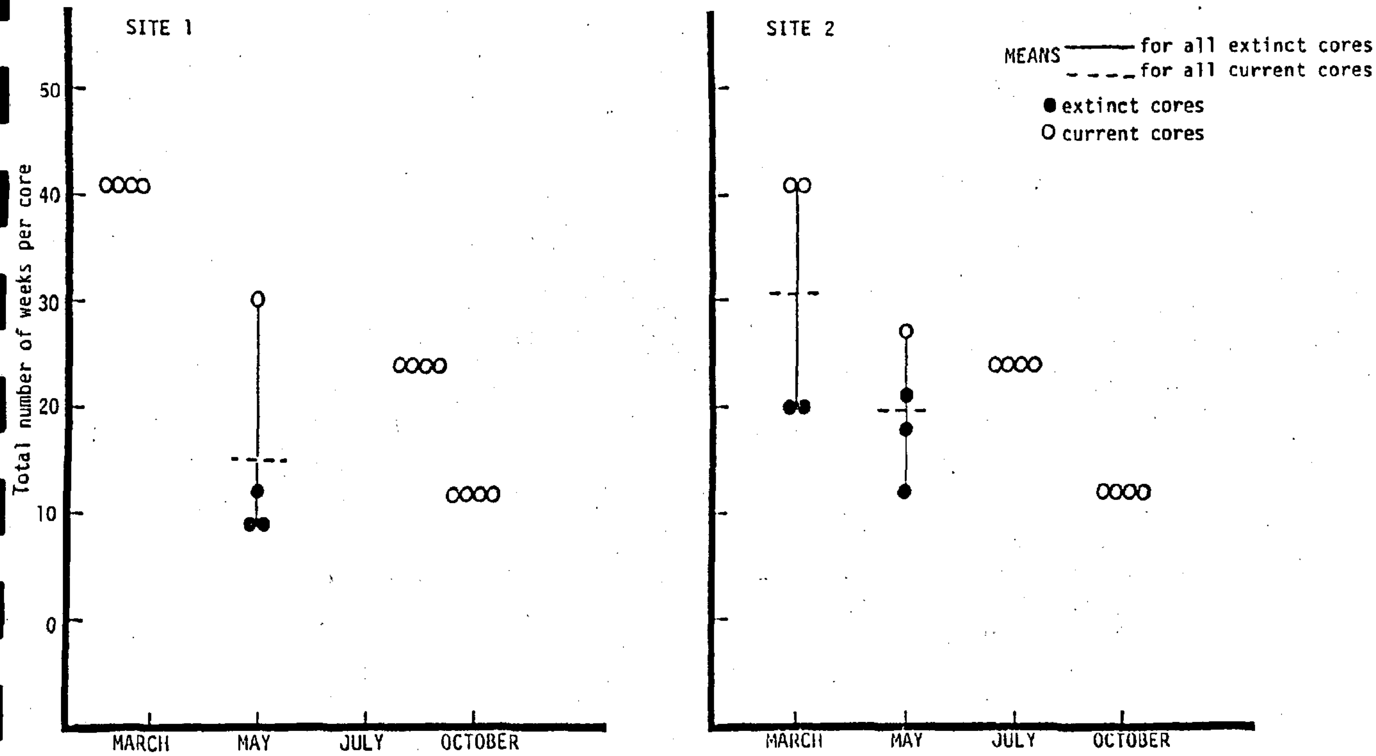

Figure 8. Number of weeks of production of Distichlis spicata as of 1 February 1988. Closed circles indicate cores no longer producing while open circles indicate cores still producing regrowth.

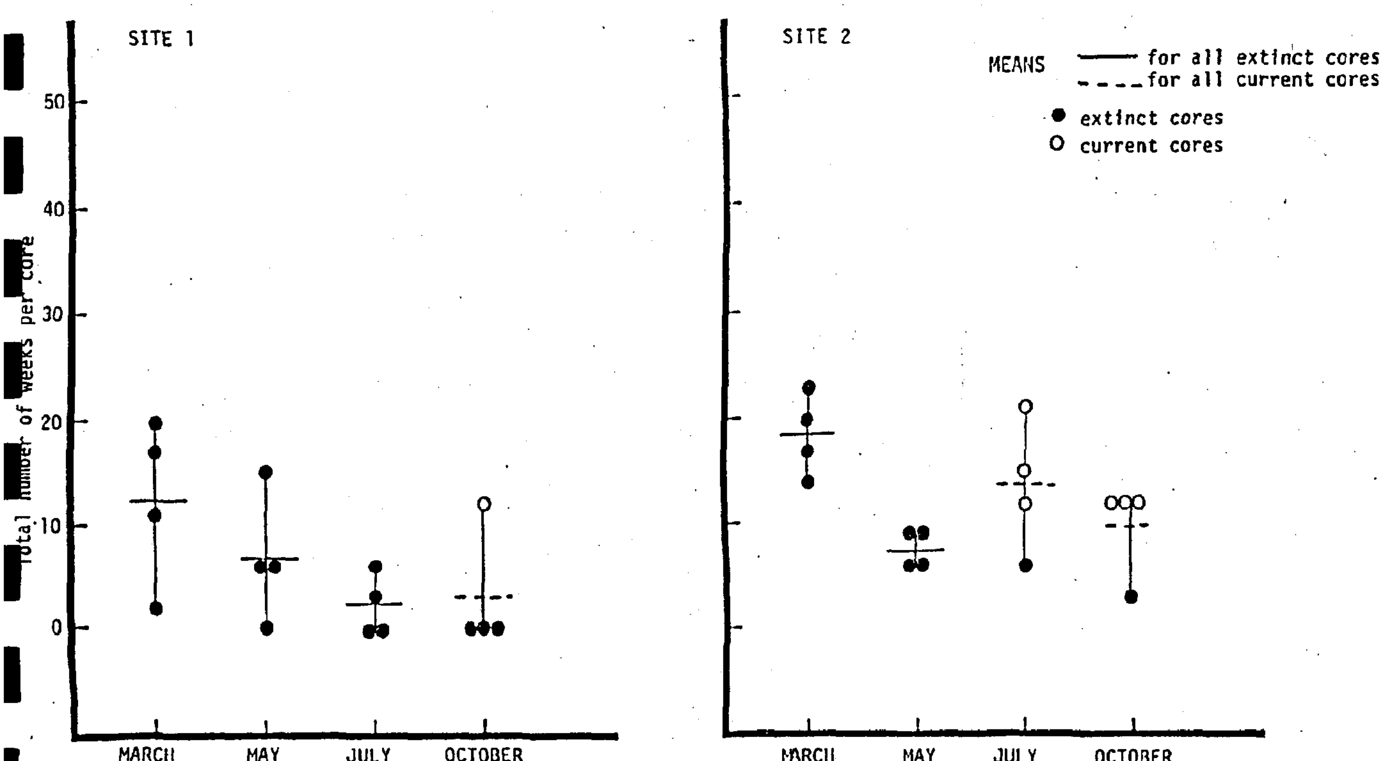

Figure 9. Number of week of production of Spartina patens as of 1 February 1988. Closed circles indicate cores no longer producing while open circles indicate cores still producing regrowth.

Table 1. Root, rhizome, and total live and dead belowground biomass profiles to a depth of 20 cm in salt marsh hay (<u>Distichlis spicata</u> and <u>Spartina patens</u>) at both sites in Canary Creek Marsh, Lewes, Delaware for March. Units are g dry weight/m^2, showing means and standard errors where N=4.

SITE 1

Live

Depth (cm)	Rhiz	Root	Total
0-5	645.1+/-89.9	67.6+/-6.8	712.6+/-83.4
5-10	461.0+/-67.3	65.4+/-4.7	526.4+/-63.4
10-15	51.0+/-22.0	56.8+/-7.9	107.4+/-22.0
15-20	8.2+/-8.2	41.2+/-13.5	49.3+/-80.4
Total	1164.8+/-100.5	230.9+/-25.9	1395.8+/-80.4

Dead

Depth (cm)	Rhiz	Root	Total
0-5	352.2+/-56.3	382.6+/-94.89	734.8+/-137.1
5-10	467.5+/-29.2	488.5+/-41.96	956.0+/-34.9
10-15	299.6+/-79.0	356.4+/-39.13	656.1+/-67.4
15-20	181.7+/-68.6	268.2+/-46.62	449.9+/-112.2
Total	1301.0+/-209.3	1495.8+/-140.2	2796.8+/-291.3

SITE 2

Live

Depth (cm)	Rhiz	Root	Total
0-5	402.6+/-36.3	52.6+/-18.2	455.1+/-53.2
5-10	471.7+/-98.0	57.0+/-25.2	528.6+/-116.6
10-15	82.2+/-46.1	51.5+/-16.7	133.7+/-54.4
15-20	4.4+/-4.4	37.4+/-11.5	41.8+/-9.1
Total	960.8+/-139.4	198.5+/-55.9	1275.3+/-200.9

Dead

Depth (cm)	Rhiz	Root	Total
0-5	304.6+/-55.9	143.8+/-73.7	448.4+/-58.8
5-10	313.4+/-55.1	209.2+/-100.6	522.6+/-50.7
10-15	15.8+/-9.1	102.0+/-47.7	117.7+/-29.6
15-20	2.4+/-1.7	37.0+/-11.5	39.4+/-12.1
Total	636.2+/-32.8	491.9+/-153.8	1128.1+/-131.4

Table 2. Root, rhizome, and total live and dead belowground biomass profiles to a depth of 20 cm in salt marsh hay (<u>Distichlis spicata</u> and <u>Spartina patens</u>) at both sites in Canary Creek Marsh, Lewes, Delaware for May. Units are g dry weight/m^2 showing means and standard errors where N=4.

SITE 1

Live

Depth (cm)	Rhiz	Root	Total
0-5	51.7+/-16.5	2.5+/-0.4	54.1+/-16.8
5-10	245.1+/-52.7	7.3+/-3.2	252.3+/-55.2
10-15	22.4+/-2.9	12.5+/-4.3	34.9+/-3.4
15-20	5.7+/-2.5	12.8+/-2.9	18.4+/-3.1
Total	324.8+/-69.0	35.0+/-9.3	359.8+/-76.3

Dead

Depth (cm)	Rhiz	Root	Total
0-5	566.3+/-74.6	253.2+/-46.6	819.5+/-97.6
5-10	670.1+/-114.6	409.8+/-18.4	1079.8+/-130.7
10-15	564.3+/-78.0	372.5+/-47.2	936.8+/-61.4
15-20	133.0+/-56.0	281.2+/-48.9	414.3+/-102.3
Total	1933.7+/-73.9	1316.8+/-122.3	3250.4+/-178.0

SITE 2

Live

Depth (cm)	Rhiz	Root	Total
0-5	43.9+/-25.6	5.2+/-0.4	49.1+/-25.7
5-10	89.9+/-30.9	3.1+/-0.3	93.0+/-31.2
10-15	67.8+/-33.2	3.9+/-1.6	71.7+/-32.9
15-20	27.7+/-14.5	3.1+/-1.5	30.8+/-14.3
Total	229.2+/-23.0	15.3+/-2.3	244.5+/-22.2

Dead

Depth (cm)	Rhiz	Root	Total
0-5	318.4+/-93.7	133.5+/-23.7	451.9+/-100.3
5-10	422.2+/-74.5	193.6+/-55.8	615.8+/-27.8
10-15	220.7+/-92.2	122.5+/-38.7	368.2+/-108.0
15-20	14.0+/-12.0	131.1+/-30.1	145.1+/-40.8
Total	975.3+/-125.6	605.7+/-189.6	1581.0+/-128.8

Table 3. Root, rhizome, and total live and dead belowground biomass profiles to a depth of 20 cm in salt marsh hay (<u>Distichlis spicata</u> and <u>Spartina patens</u>) at both sites in Canary Creek Marsh, Lewes, Delaware for July. Units are g dry weight/m^2, showing means and standard errors where N=4.

SITE 1

Live

Depth (cm)	Rhiz	Root	Total
0-5	227.6+/-74.2	6.7+/-2.3	234.3+/-76.4
5-10	452.0+/-82.7	45.3+/-8.0	332.6+/-89.9
10-15	67.1+/-51.6	17.4+/-6.6	84.5+/-56.7
15-20	3.4+/-2.1	25.1+/-5.4	28.6+/-7.1
Total	750.1+/-88.6	94.5+/-4.2	680.0+/-20.2

Dead

Depth (cm)	Rhiz	Root	Total
0-5	272.2+/-109.0	672.5+/-521.5	944.7+/-610.3
5-10	390.3+/-146.4	450.7+/-118.0	841.0+/-247.6
10-15	333.1+/-105.2	788.1+/-451.9	1121.2+/-432.8
15-20	116.0+/-44.6	587.0+/-257.2	700.5+/-248.4
Total	1111.5+/-332.4	2498.4+/-1329.4	3607.4+/-1468.9

SITE 2

Live

Depth (cm)	Rhiz	Root	Total
0-5	269.1+/-37.4	23.9+/-5.0	293.0+/-39.3
5-10	392.4+/-40.8	45.0+/-7.2	437.4+/-46.6
10-15	130.7+/-48.7	24.8+/-12.7	87.8+/-21.0
15-20	3.6+/-2.2	20.2+/-11.1	23.8+/-12.9
Total	795.7+/-28.6	113.9+/-11.3	841.9+/-63.3

Dead

Depth (cm)	Rhiz	Root	Total
0-5	281.5+/-95.4	554.9+/-201.6	836.4+/-258.6
5-10	548.7+/-96.3	587.7+/-125.4	1136.4+/-168.5
10-15	31.9+/-19.1	356.9+/-81.5	388.8+/-81.6
15-20	0.0+/-0.0	110.0+/-40.8	110.0+/-40.8
Total	862.1+/-71.9	1609.4+/-368.0	2471.5+/-330.9

Table 4. Root, rhizome, and total live and dead belowground biomass profiles to a depth of 20 cm in salt marsh hay (*Distichlis spicata* and *Spartina patens*) at both sites in Canary Creek Marsh, Lewes, Delaware for October. Units are g dry weight/m^2 showing means and standard errors where N=4.

SITE 1

Live

Depth (cm)	Rhiz	Root	Total
0-5	400.2+/-49.2	25.4+/-6.3	425.53+/-54.5
5-10	507.7+/-94.5	70.4+/-12.3	578.13+/-101.6
10-15	107.1+/-103.2	50.8+/-7.1	157.94+/-105.7
15-20	1.4+/-1.1	32.1+/-4.9	33.52+/-5.4
Total	1016.5+/-117.5	178.7+/-19.7	1195.12+/-125.5

Dead

Depth (cm)	Rhiz	Root	Total
0-5	341.7+/-44.6	211.3+/-26.3	553.0+/-52.4
5-10	623.8+/-107.7	385.9+/-59.7	1009.7+/-162.3
10-15	227.3+/-70.0	294.1+/-15.6	521.4+/-77.0
15-20	136.6+/-49.7	183.3+/-34.5	319.9+/-78.6
Total	1329.4+/-55.9	1074.7+/-89.5	2404.1+/-138.4

SITE 2

Live

Depth (cm)	Rhiz	Root	Total
0-5	337.7+/-49.4	41.6+/-5.6	379.2+/-53.1
5-10	487.9+/-166.4	57.5+/-9.7	545.5+/-160.9
10-15	190.1+/-71.0	57.5+/-10.4	247.6+/-76.8
15-20	1.6+/-1.1	43.7+/-7.8	45.2+/-7.5
Total	1017.3+/-163.1	200.3+/-24.1	1217.6+/-162.4

Dead

Depth (cm)	Rhiz	Root	Total
0-5	409.1+/-45.1	281.7+/-60.0	690.8+/-48.5
5-10	501.2+/-62.7	234.0+/-51.2	735.2+/-100.7
10-15	65.1+/-28.4	145.1+/-10.7	210.2+/-20.6
15-20	1.9+/-1.9	85.3+/-8.3	87.2+/-9.6
Total	977.3+/-42.2	746.0+/-48.6	1723.3+/-55.4

observations made while washing these core segments, largest quantities of live biomass appeared to exist mostly in the 5-to-10 cm segments for both root and rhizome components at both sites for all samplings (except in the 0-to-5 cm segments for March and May roots at Site 1 and 2, respectively, and for March rhizomes at Site 1). Dead biomass also followed a similar trend (except in the 0-to-5 cm segments for October and July roots at Site 2). Additionally, it is quite evident that most of the live material is found in the upper 15 cm of the marsh profiles at both sites and that the biomass of the rhizomes is much greater than that of the roots. At this point we will say no more until we have time to study the data in depth since these results were only recently compiled and we have not as yet had sufficient time to evaluate fully our findings.

The holes where the cores were removed for both the belowground profile and recoverable reserve studies (described above) were refilled with ditching spoil from which the living roots and rhizomes were removed. Both core holes were re-cored the next sampling time and the new growth into that unoccupied soil is represented in Table 5 which indicates that the minimum growth of both roots and rhizomes in these recores was in the March-to-May period with higher growth rates occurring from May to July and the highest rates in the July-to-October period. (Although the final re-coring of the October 1987 cores will not occur until March 1988, we do not anticipate finding high rates during the winter which is the expected dormant phase of the growing season.) This growth pattern may help to explain the poor recovery of the March burial plants as evidenced by aerial production when compared with the May plots (Figures 3, 4, and 5). If this logic is extended, the October-buried plots would be expected to do well this spring. However, considering the danger of such extrapolation (especially since the original working hypothesis was that March is the best time to cover these plant species because their reserve patterns were anticipated to be similar to that for Spartina alterniflora which has maximum amount of available reserves during the early part of the growing season), we cannot safely draw any conclusions or possible explanations from this data at this time.

Table 5. Root and rhizome growth into unoccupied soil at both sites in salt marsh hay (*Distichlis spicata* and *Spartina patens*) at both sites in Canary Creek Marsh, Lewes, Delaware. Units are g dry weight/m^2/month showing means and standard errors where N=4.

	March - May	May - July	July - October
SITE 1			
Rhiz	9.57+/-2.33	13.68+/-2.25	24.09+/-5.83
Root	2.50+/-0.66	4.33+/-0.34	8.66+/-0.67
Total	12.03+/-2.76	18.01+/-2.35	32.75+/-5.60
SITE 2			
Rhiz	3.88+/-1.77	9.31+/-3.33	20.74+/-5.49
Root	1.67+/-0.43	3.32+/-0.76	6.28+/-0.33
Total	5.55+/-1.71	12.63+/-3.50	26.60+/-5.70